TOPIC 4

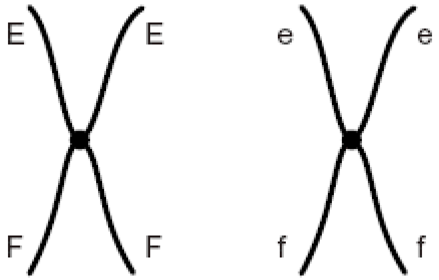
Genetic Diversity & Species Diversity

Pack 2

A Level Yr1/AS

Q2.Figure 1 shows a pair of chromosomes at the start of meiosis. The letters represent alleles.

Figure 1



(a) What is an allele?

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(1)

(b) Explain the appearance of one of the chromosomes in **Figure 1**.

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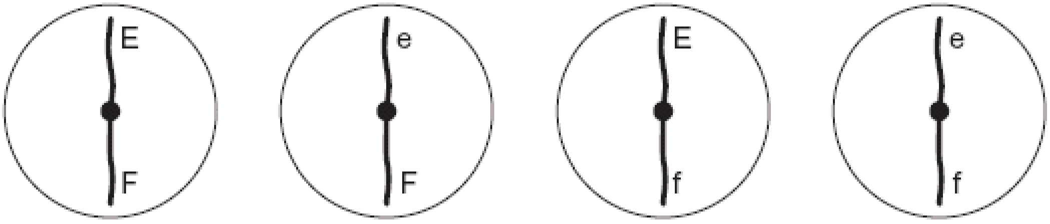
(2)

(c) The cell containing this pair of chromosomes divided by meiosis. **Figure 2** shows the distribution of chromosomes from this pair in four of the gametes produced.

Figure 2



(i) Some of the gametes formed during meiosis have new combinations of alleles.

Explain how the gametes with the combinations of alleles Ef and eF have been produced.

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(2)

(ii) Only a few gametes have the new combination of alleles Ef and eF. Most gametes have the combination of alleles EF and ef. Suggest why only a few gametes have the new combination of alleles, Ef and eF.

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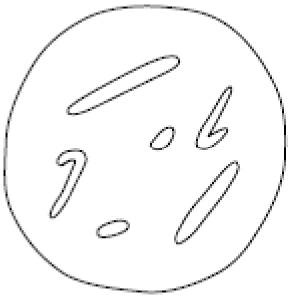
(1)

(d) **Figure 3** shows a cell with six chromosomes.

Figure 3



(i) This cell produces gametes by meiosis. Draw a diagram to show the chromosomes in one of the gametes.

(2)

(ii) How many different types of gametes could be produced from this cell as a result of different combinations of maternal and paternal chromosomes?

☐

(1)
(Total 9 marks)

Q4. (a) Apart from increasing genetic variation, explain why meiosis is important in organisms which reproduce sexually.

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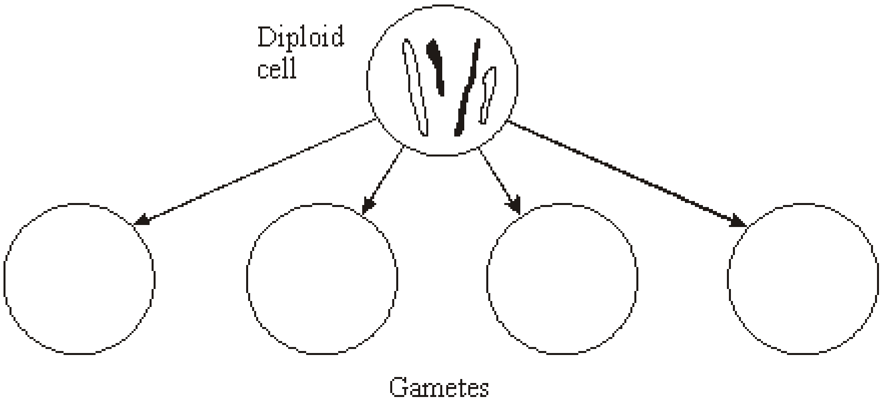
(2)

(b) **Figure 1** shows the chromosomes in a diploid cell.

Figure 1

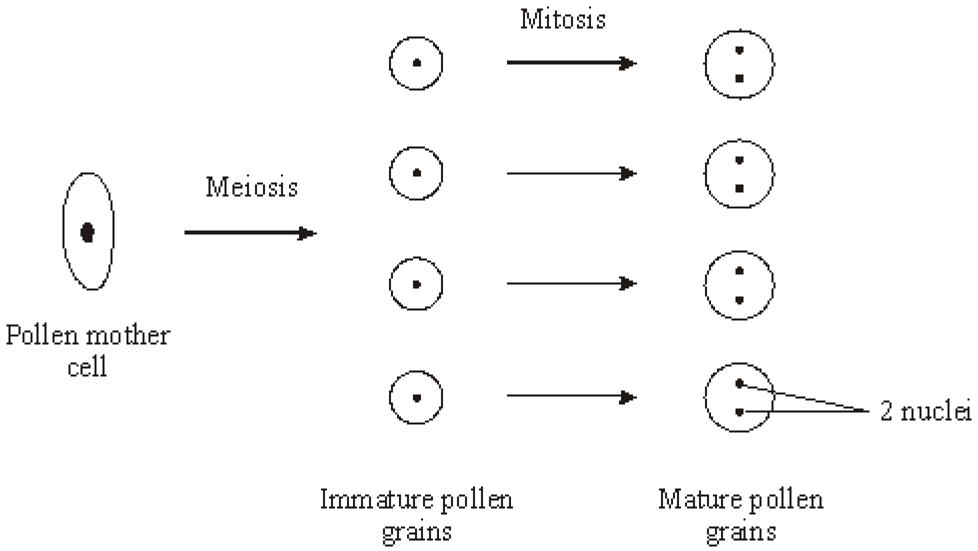


Complete **Figure 1** to show the four different combinations of these chromosomes in the gametes produced by meiosis.

(2)

(c) **Figure 2** shows the main stages in the production of pollen grains in a flowering plant.

Figure 2



The diploid number of chromosomes in this plant is sixteen. How many chromosomes would there be in

(i) the nucleus of an immature pollen grain;

....

(ii) one of the nuclei of a mature pollen grain?

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(2)

(d) In tissues that produce gametes, there is a greater proportion of cells undergoing meiosis in male tissue than in female tissue. Suggest **one** advantage of this.

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(1)
(Total 7 marks)

Q6. (a) Describe what happens to chromosomes in meiosis.

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(6)

(b) Meiosis results in genetic variation in the gametes which leads to variation in the offspring formed by sexual reproduction. Describe how meiosis causes this variation and explain the advantage of variation to the species.

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(5)

(c) An old form of wheat, emmer wheat (*Triticum turgidum*), has a diploid chromosome number of 28 (2n = 28). A wild wheat, einkorn wheat (*Triticum tauschii*), has a diploid chromosome number of 14 (2n = 14). These two species occasionally crossed and produced sterile hybrid plants. Due to an error during cell division, one of these hybrid plants formed male and female gametes with 21 chromosomes. Fusion of these gametes resulted in viable offspring. These plants were a new species, *Triticum aestivum* (2n = 42), our modern bread wheat.

(i) How many chromosomes would there have been in each of the cells of the hybrid plant produced by crossing *Triticum turgidum* with *Triticum tauschii*?

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(1)

(ii) Explain why *Triticum aestivum* is fertile while the majority of hybrid plants were not.

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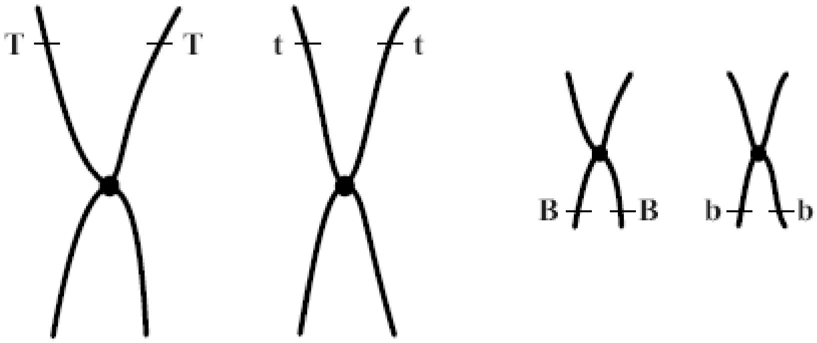
(3)
(Total 15 marks)

Q8. (a) **Figure 1** shows two pairs of chromosomes from a plant cell. The letters represent alleles.

Figure 1



(i) Give all the different genotypes of the gametes which could be produced by this plant.

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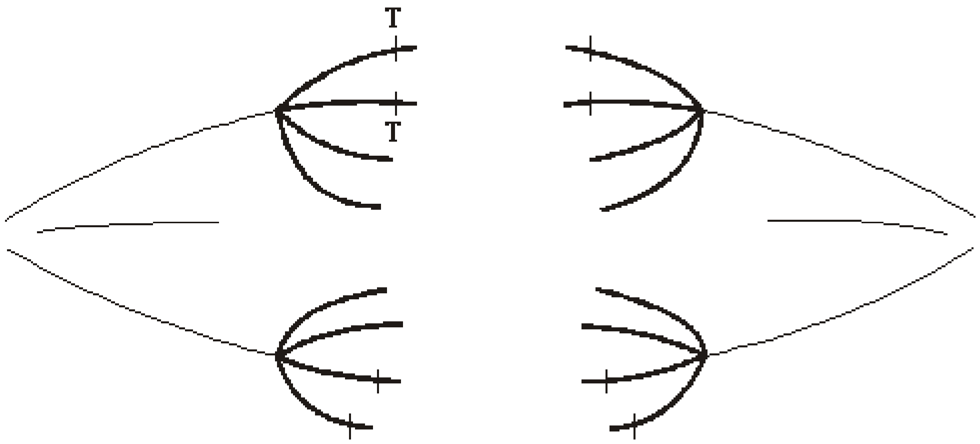
(1)

(ii) **Figure 2** shows the same chromosomes on the spindle during meiosis. Complete the labelling of all the chromosomes to show the arrangement of the alleles that would result in the production of a gamete with the genotype **TB**.

Figure 2



(1)

(iii) One chromosome has two copies of allele **T**. What occurs during meiosis which results in only one copy of the allele **T** being present in a gamete?

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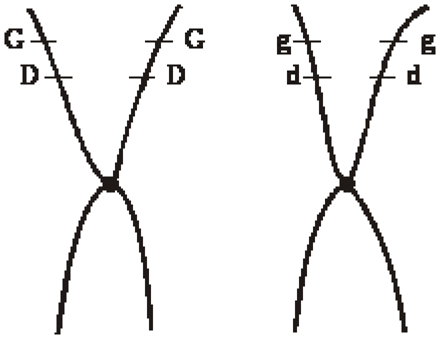
(1)

(b) **Figure 3** shows another pair of chromosomes from the same plant cell. The table shows the numbers of gametes with each genotype produced by this plant.

Figure 3



Genotype of gametes	**GD**	**gd**	**Gd**	**gD**
Number of gametes	1096	1124	210	230

(i) Describe what happens during meiosis, which results in the new combinations of alleles, **Gd** and **gD**.

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(3)

(ii) Suggest why there are fewer gametes with genotypes **Gd** and **gD** than **GD** and **gd**.

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(1)
(Total 7 marks)

Q10. (a) Explain how crossing over can contribute to genetic variation.

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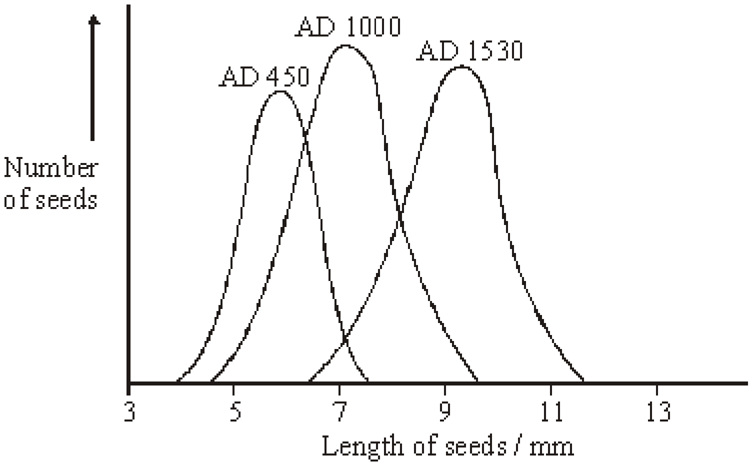
(3)

(b) Maize seeds were an important food crop for the people who lived in Peru. The seeds could be kept for long periods. Each year, some were sown to grow the next crop. Archaeologists have found well-preserved stores. The graph shows the lengths of seeds collected from three stores of different ages.



(i) Within each store the maize seeds showed a range of different lengths. Explain **one** cause of this variation.

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(2)

(ii) Use your knowledge of genetics and selection to explain the changes in the mean length of the seeds between AD 450 and AD 1530.

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(4)
(Total 9 marks)

Q12. (a) Explain the importance of meiosis in the life cycles of organisms which reproduce sexually.

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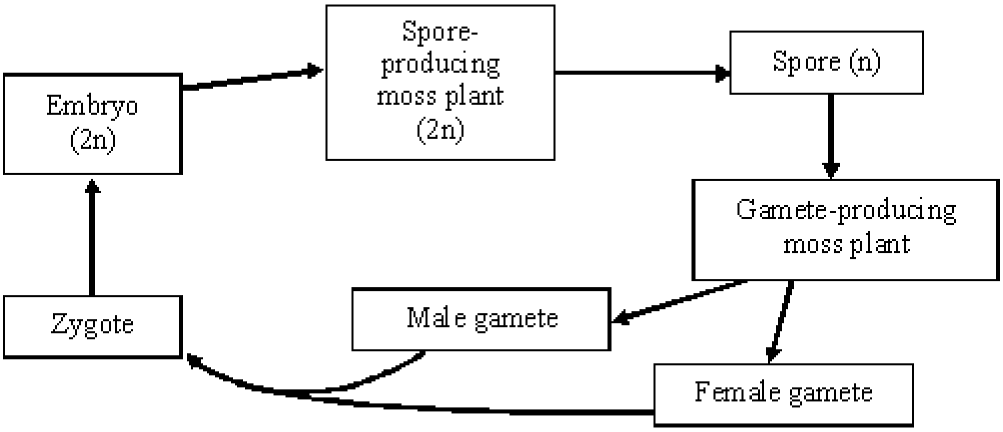
(3)

(b) The diagram shows the life cycle of a moss plant.



On the diagram mark with an **M** where meiosis takes place.

(1)
(Total 4 marks)

Q14. The table shows some differences between three varieties of banana plant.

	Variety **A**	Variety **B**	Variety **C**
Number of chromosomes in a leaf cell	22	33	44
Growth rate of fruit / cm^3 $week^{-1}$	2.9	6.9	7.2
Breaking strength of leaf / arbitrary units	10.8	9.4	7.8

(a) (i) How many chromosomes are there in a male gamete from variety **C**?

☐

(1)

(ii) Variety **B** cannot produce fertile gametes. Use information in the table to explain why.

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(2)

In some countries very strong winds may occur. Banana growers in these countries choose to grow variety **B**.

(b) (i) Use the data in the table to explain why banana growers in these countries choose to grow variety **B** rather than variety **A**.

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(1)

(ii) Use the data in the table to explain why banana growers in these countries choose to grow variety **B** rather than variety **C**.

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(1)

(c) Banana growers can only grow new variety **B** plants from suckers. Suckers grow from cells at the base of the stem of the parent plant.

Use your knowledge of cell division to explain how growing variety **B** on a large scale will affect the genetic diversity of bananas.

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(2)

(Total 7 marks)

Q16. Phenylketonuria is a disease caused by mutations of the gene coding for the enzyme PAH. The table shows part of the DNA base sequence coding for PAH. It also shows a mutation of this sequence which leads to the production of non-functioning PAH.

DNA base sequence coding for PAH	C	A	G	T	T	C	G	C	T	A	C	G
DNA base sequence coding for non-functioning PAH	C	A	G	T	T	C	C	C	T	A	C	G

(a) (i) What is the maximum number of amino acids for which this base sequence could code?

☐

(1)

(ii) Explain how this mutation leads to the formation of non-functioning PAH.

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(*Extra space*) ....

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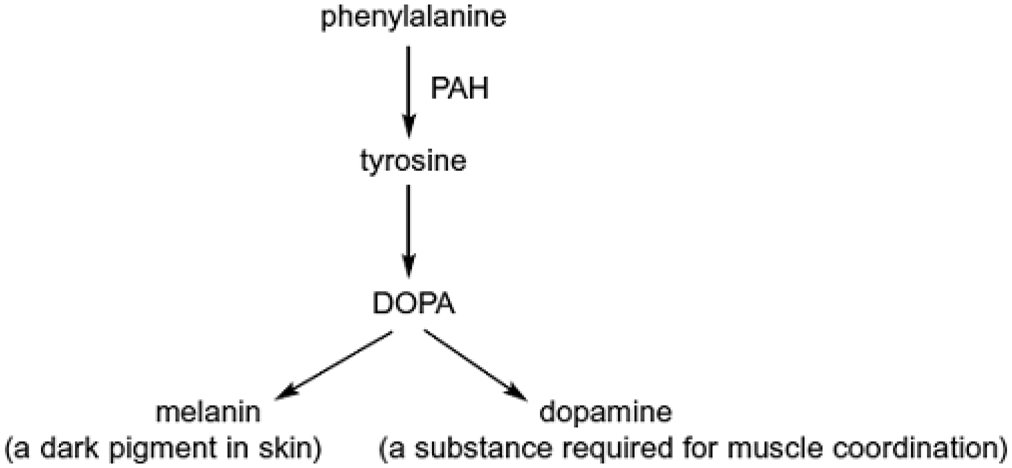
(3)

PAH catalyses a reaction at the start of two enzyme-controlled pathways.
The diagram shows these pathways.



(b) Use the information in the diagram to give **two** symptoms you might expect to be visible in a person who produces non-functioning PAH.

1 ....

2 ....

(2)

(c) One mutation causing phenylketonuria was originally only found in one population in central Asia. It is now found in many different populations across Asia. Suggest how the spread of this mutation may have occurred.

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(1)

Q18. (a) Explain what is meant by genetic diversity.

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(1)

(b) Apart from genetic factors what other type of factor causes variation within a species?

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(1)

(c) The spotted owl is a bird. Numbers of spotted owls have decreased over the past 50 years. Explain how this decrease may affect genetic diversity.

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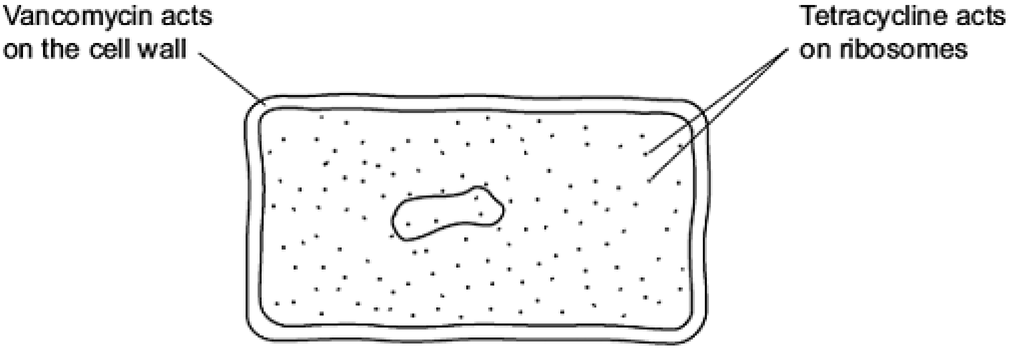
(2)

(Total 4 marks)

Q20. The diagram shows the structure of a bacterium and the sites of action of two antibiotics.


Vancomycin acts on the cell wall
Tetracycline acts on ribosomes

(a) (i) Use information in the diagram to explain why vancomycin does **not** affect human cells.

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(1)

(ii) Use information in the diagram to explain how tetracycline prevents bacterial growth.

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(1)

(b) Frequent treatment with vancomycin can result in resistant strains of bacteria. Explain how.

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(Extra space) ....

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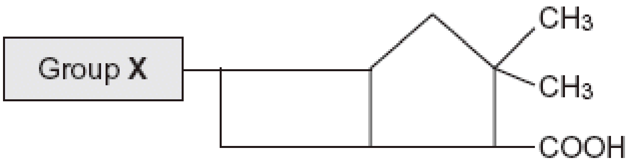
(2)

(Total 4 marks)

Q22. Penicillins are antibiotics. Some bacteria produce an enzyme that breaks down one sort of penicillin.

(a) There are different sorts of penicillin. All of these have the same basic chemical structure shown in the diagram but group **X** is different.



A bacterial infection that cannot be treated with one sort of penicillin can be treated with a different sort. Use your knowledge of enzyme action to explain why the different sort of penicillin is effective in treating the infection.

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(3)

(b) Farmers often keep large numbers of cattle together. Farmers used to give cattle food which had antibiotics added to it.

(i) Suggest how adding antibiotics to the food of the cattle increased profit for the farmers.

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(2)

(ii) Adding antibiotics to the food of cattle is now banned in many countries. Use your knowledge of selection to explain why adding antibiotics was banned.

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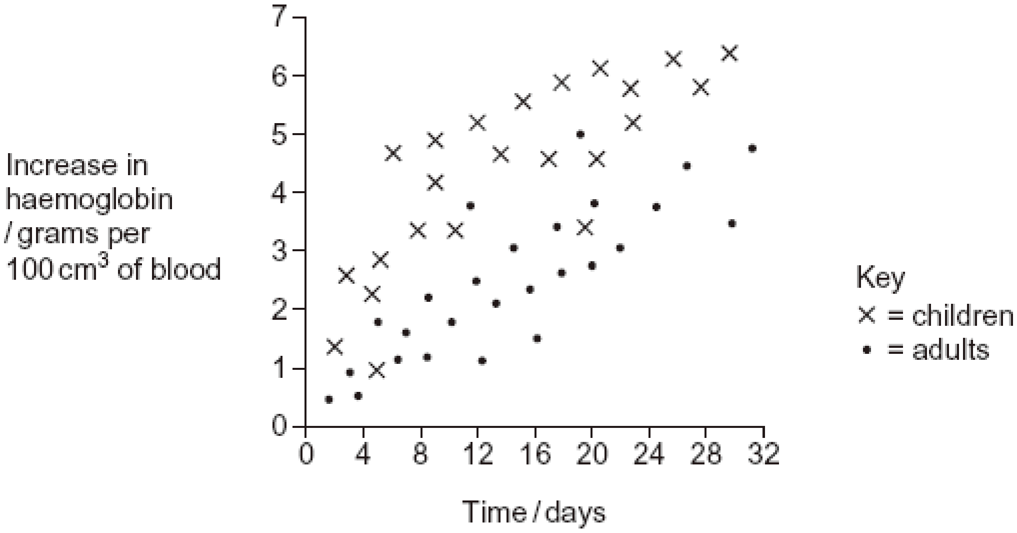
(2)

(Total 7 marks)

Q24. (a) Haemoglobin contains iron. One type of anaemia is caused by a lack of iron. This type of anaemia can be treated by taking tablets containing iron. A number of patients were given a daily dose of 120 mg of iron. **Figure 1** shows the effect of this treatment on the increase in the concentration of haemoglobin in their red blood cells.

Figure 1



(i) Give **one** difference in the response of adults and children to this treatment.

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(1)

(ii) You could use the graph to predict the effect of this treatment on the increase in haemoglobin content of an adult after 40 days. Explain how.

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(2)

(iii) Haemoglobin has a quaternary structure. Explain what is meant by a quaternary structure.

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(1)

(b) (i) Pernicious anaemia is another type of anaemia. One method of identifying pernicious anaemia is to measure the diameter of the red blood cells in a sample of blood that has been diluted with an isotonic salt solution. Explain why an isotonic salt solution is used to dilute the blood sample.

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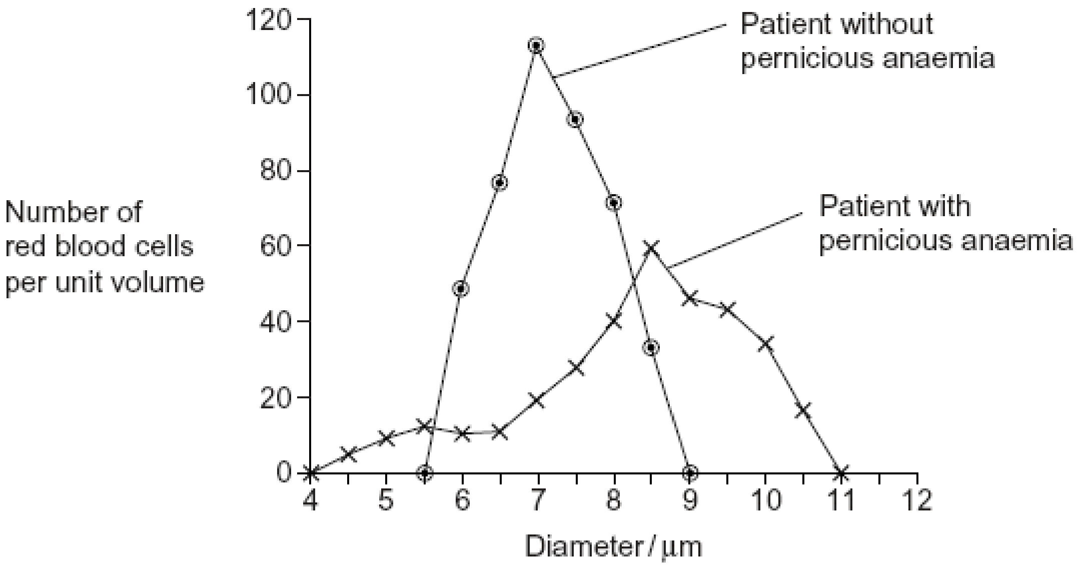
(3)

(ii) A technician compared the red blood cells in two blood samples of equal volume. One sample was from a patient with pernicious anaemia, the other was from a patient who did not have pernicious anaemia. **Figure 2** shows some of the results she obtained.

Figure 2



Describe **two** differences between the blood samples.

1 ....

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2 ....

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(2)
(Total 9 marks)

Q26. (a) In an investigation, two sterile agar plates were inoculated with bacteria from the same culture. Then, using a syringe, 2 cm^3 of an antibiotic solution were added to plate **1** and 2 cm^3 of sterile water were added to plate **2**. The diagram shows the plates after 24 hours.

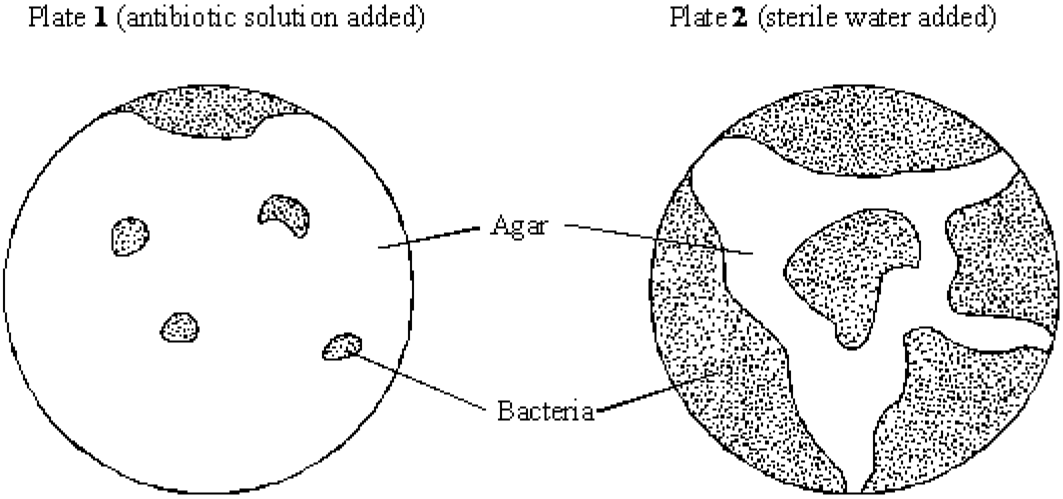
Plate 1 (antibiotic solution added)
Plate 2 (sterile water added)
Agar
Bacteria

(i) At the start of the investigation, the agar was sterilised. Explain why.

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(1)

(ii) The water was added to plate **2** as a control. Explain why this control was necessary.

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(1)

(b) Explain why some bacteria were able to grow on plate **1**.

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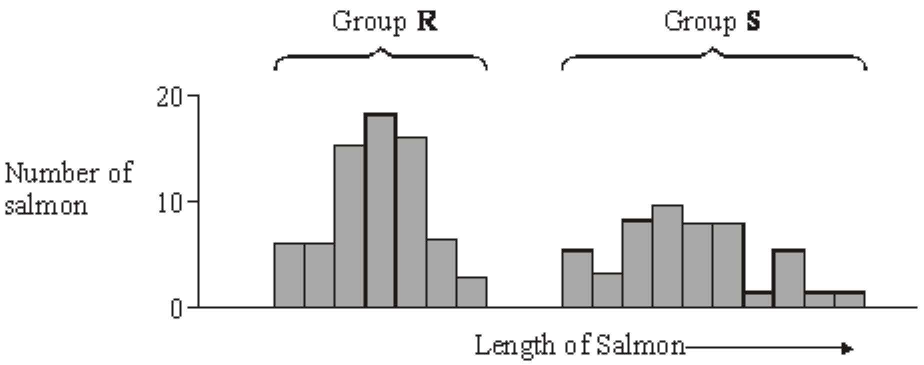
(1)
(Total 3 marks)

Q28. The graph shows the variation in length of 86 Atlantic salmon.



(a) Give **two** possible causes of this variation that result from meiosis during gamete formation.

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2 ....

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(2)

(b) When comparing variation in size between two groups of organisms, it is often considered more useful to compare standard deviations rather than ranges. Explain why.

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(2)
(Total 4 marks)

Q30. The National Vegetable Research Station stores a collection of seeds from many species and varieties of vegetables. These include old and rare varieties.

S (a) Why is it important to keep seeds from old and rare varieties of vegetables?

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(2)

S (b) Every few years, seeds of each variety in the collection are germinated and grown into mature plants. New seeds obtained from these plants are added to the collection.

(i) Suggest why it is necessary to obtain new seeds every few years.

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(1)

(ii) Within each variety, the scientists cross plants with different genotypes. Explain the advantage of this.

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(2)
(Total 5 marks)

Q32. The Amish are a group of people who live in America. This group was founded by 30 Swiss people, who moved to America many years ago. The Amish do not usually marry people from outside their own group.

One of the 30 Swiss founders had a genetic disorder called Ellis-van Creveld syndrome. People with this disorder have heart defects, are short and have extra fingers and toes. Ellis-van Creveld syndrome is caused by a faulty allele.

In America today, about 1 in 200 Amish people are born with Ellis-van Creveld syndrome. This disorder is very rare in people in America who are not Amish.

(a) Use the information provided and your knowledge of the founder effect to explain why Ellis-van Creveld syndrome occurs at a higher frequency in the Amish population than in people in America who are not Amish.

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(3)

(b) In America today, there are approximately 1250 Amish people who have Ellis-van Creveld syndrome. Use the information provided to calculate the current Amish population of America.

Amish population ....

(1)

(c) The faulty allele that causes Ellis-van Creveld syndrome is the result of a mutation of a gene called *EVC.* This mutation leads to the production of a protein that has one amino acid missing.

(i) Suggest how a mutation can lead to the production of a protein that has one amino acid missing.

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(2)

(ii) Suggest how the production of a protein with one amino acid missing may lead to a genetic disorder such as Ellis-van Creveld syndrome.

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(2)

(Total 8 marks)

M2.(a) (Different) form / type / version of a gene / different base sequence of a gene;

1

(b) Two / sister chromatids joined by a centromere;

Due to DNA replication;

2

(c) (i) Crossing over;

1

Exchange (of alleles) between chromatids / chromosomes;

Negate first marking point for answers which refer to independent segregation.

Chiasma / chiasmata = first marking point

1

(ii) Is infrequent / rare;

References to it being 'random', 'occurs by chance' or 'doesn't always occur' should not be credited without a clear idea that it is rare or infrequent.

1

(d) (i) Three chromosomes shown;

1

One from each homologous pair;

For first mark point allow drawings showing three chromosomes as single or double structures.

1

(ii) 8;

1

[9]

M4. (a) haploid cells produced / halves chromosome number;
fertilisation / fusion of gametes, diploid number restored;
chromosome number constant at each generation;

2 max

(b) principle of 2 chromosomes per cell;
4 correct combinations, long with short;

2

(c) (i) 8;

(ii) 8;

2

(d) (in males) more gametes produced / rapid gamete production / more lost;

1

[7]

M6. (a)
1. Chromosomes shorten / thicken / condense;
2. Chromosomes associate in homologous / (described) pairs / formation of bivalents / tetrads;
3. Crossing-over / chiasma formation;
4. Join to spindle (fibres) / moved by spindle;(*)
5. (At) equator / middle of cell;(*)
6. (join via) centromere / kinetochore;(*)
7. (Homologous) chromosomes move to opposite poles / chromosomes separate / move apart; (*ALLOW* 'are pulled apart')
8. (Pairs of) chromatids separated in 2nd division;

(*) OR " independent assortment"
unqualified = 1 mark

max 6

(b)
1. Crossing-over; [*IGNORE* any wrong ref. to timing]
2. Independent / random assortment / orientation / segregation of (homologous) chromosomes in meiosis I;
3. Independent / random assortment / orientation / segregation of chromatids in meiosis II;

+ Any **three** from:

4. Different adaptations / some better adapted;
5. Some survive / example described;

6. To reproduce;
7. Pass on gene / allele;
8. Allows for changing environment / different environment / example described;

max 5

(c) (i) 21;

1

(ii) 1. *T. aestivum* has 2 copies of each type of chromosome / is diploid;
2. *T. aestivum's* chromosomes can form bivalents / can assort in meiosis / can produce haploid gametes;
3. *T. aestivum's* gametes receive a copy of every chromosome / receive all the genetic information;

ACCEPT converse argument for hybrid plants

3

[15]

M8. (a) (i) TB Tb tB tb;

1

(ii) homologous chromosomes appropriately labelled;

1

(iii) separation of chomatids;

1

(b) (i) crossing over occurs;
between **D** and **G**;
sections of chromatids / chromosomes / DNA / genes exchanged;

3

(ii) crossing over is infrequent(between close genes);

1

[7]

M10. (a) sections of chromatids exchanged;
sections have different alleles;
new combinations of (linked) alleles;

(allow 1 mark for idea that 'genes' are exchanged, if no other marks gained)

3

(b) (i) length controlled by many genes / polygenes;
each gene may have different alleles / idea of additive effects;
OR
environmental factors / or named factor;
how named factor may affect growth of seeds;

2 max

(ii) 1. selection of large seeds for sowing;
2. higher proportion of alleles for long length / loss of alleles for short seeds from population;
3. (possible appearance of) new alleles through mutation;
4. process repeated over many generations;

(G - allow 1 mark idea for that 'largeness' selected, survives and inherited)

4

[9]

QWC 1

M12. (a) meiosis halves the chromosome number / from diploid to haploid / produces haploid / n cells;
when gametes fuse / at fertilisation, the diploid number is restored / this keeps the chromosome number constant / correct from one generation to the next / after sexual reproduction;
introduces genetic variation / independent assortment / crossing over;

3

(b) **M** between moss plant and spore;

1

[4]

M14. (a) (i) 22;

1

(ii) 1. Odd number of chromosomes / 33 chromosomes (in leaf cell);

2. Chromosomes cannot pair / cannot undergo meiosis / would result in half chromosomes / cannot form haploid cells;

2

(b) (i) Fast growth / produces crop fast / produces large crop;

Do not insist on relative statement.

Accept similar terms for fast. E.g. “better” growth

Do not accept unqualified references to profit.

1

(ii) Leaves less likely to break / higher breaking strength;

1

(c) Low genetic diversity because they are produced by mitosis;

Will all have the same DNA / genes / alleles / will be genetically identical / will be clones;

OR

Low genetic diversity because they are not produced by meiosis;

No crossing over / independent segregation / will not be genetically different;

Independent segregation is the specification term. Accept other such as random assortment.

2

[7]

M16.(a) (i) 4;

1

(ii) 1. Change in amino acid / (sequence of) amino acids / primary structure;

1. Reject = different amino acids are 'formed'

2. Change in hydrogen / ionic / disulphide bonds alters tertiary

structure / active site (of enzyme);

2. Alters 3D structure on its own is not enough for this marking point.

3. Substrate not complementary / cannot bind (to enzyme / active site) / no enzyme- substrate complexes form;

3

(b) 1. Lack of skin pigment / pale / light skin / albino;

2. Lack of coordination / muscles action affected;

2 max

(c) Founder effect / colonies split off / migration / interbreeding;

Allow description of interbreeding e.g. reproduction between individuals from different populations

1

[7]

M18. (a) Difference in DNA / base sequence / difference in alleles / genes / gene pool;

Neutral: 'fewer alleles' unless qualified e.g. fewer different alleles.

1

(b) Environmental;

Accept: Environment

1

(c) Reduced (genetic diversity);

As fewer different / varied alleles / genes / reduced gene pool;

2

[4]

M20.(a) (i) (Human cells) don't have a cell wall;

Accept "they" refers to human cells.

1

(ii) (Affects) protein synthesis;

Allow description e.g. 'amino acids not joined together / translation.

Reject: affects transcription.

1

(b) 1. Mutation present / occurs;

Ignore antibiotic causes mutation.

2. Resistance gene / allele;

1. or 2.

Reference to immunity disqualifies first credited marking point.

3. Resistant bacteria (survive and) reproduce;

Reference to mitosis negates marking point 3.

2

[4]

M22. (a) **Shape**

1. Different penicillin has different shape / structure / enzyme / active site has specific shape / structure;

   Not different

Binding

2. No longer fits / binds to active site / not complementary to active site / does not form E-S complex;

Consequence

3. (Different) penicillin not broken down;

3

(b) (i) 1. Kills pathogenic / harmful bacteria / pathogens;

2. Disease less likely / improves health / animals healthier / reduces spread of infection;

3. Faster growth / more productive animals / more food converted to meat / greater survival / lower vet's bills / increased yield / less energy (for "fighting infection");

   Principles:

   Action of antibiotic. Do not accept stops all disease

   Action on health

   Effect on production

2 max

(ii) 1. (Adding antibiotics) selects in favour of antibiotic resistance / resistant bacteria more likely to survive;

2. Increase in numbers / higher proportion of resistant bacteria;

   Penalise immune only on the first occasion it occurs in this part of the question.

2

[7]

M24. (a) (i) Faster / greater / more effective response in children;

Do not accept children have more haemoglobin

1

(ii) Use line of best fit;

1

Extrapolate / extend line (and read from graph);

Allow calculation using rate of increase per day = one mark. However for both marks this must be linked to line of best fit.

1

(iii) More than one polypeptide chain;

Allow many polypeptide chains.

'Haemoglobin has four polypeptide chains' must be in correct context to gain mark.

1

(b) (i) Has same water potential;

Allow converse for effect of using distilled water or a concentrated solution.

1

No (net) water movement / osmosis;

1

Cells will not swell / burst / change size;

No osmotic lysis = two marks

1

(ii) Pernicious anaemia (cells) greater range / spread / variation of diameters / widths;

Some pernicious anaemia (cells) wider than 9 (µm) / some less than 5.5 (µm) / without pernicious anaemia none more than 9 (µm) / none less than 5.5 (µm);

Pernicious anaemia (cells) peak / most frequent at 8.5 (µm) / peak / most frequent at higher diameter / / without pernicious anaemia peak / most frequent at 7 (µm) / peaks at lower diameter;

There are several alternatives for marking points 2 and 3

2 max

[9]

M26. (a) (i) to ensure that no unwanted bacteria will be present;

1

(ii) to check that bacteria cells do not die anyway / to show water / solvent has no effect on growth;

1

(b) some bacteria are resistant / some areas of dish have no antibiotic / antibiotic not spread evenly;

1

[3]

M28. (a) (i) Continuous variation – range of values / not discrete categories / many categories / no gaps;

1

(ii) Crossing over / chiasmata;
Random segregation / independent assortment;
In meiosis I and meiosis II;

max 2

(b) Range influenced by single ‘outlier’ (*accept anomaly*) / converse for S.D.;
S.D. shows dispersion / spread about mean / range only shows highest and lowest values / extremes;
Or
S.D. allows statistical use;
Tests whether or not differences are significant;

max 2

[4]

M30. (a) limited genetic diversity in modern varieties / greater genetic diversity in old varieties / older varieties contain other (useful)

alleles / genes;
old varieties useful for future breeding programmes;

2

(b) (i) seeds lose viability / will not germinate / develop after long storage;

1

(ii) preserve variety of alleles / different genotypes / maintain genetic variation;
prevent inbreeding / reduces the chance of homozygosity;

2

[5]

M32.(a) 1. Population formed by a small number of founders / people / 30 people / less genetic diversity / small(er) gene pool / less variety of alleles;

Accept: converse arguments for the non-Amish population

1. ***Q*** *Neutral: fewer alleles*

2. Individuals breed within group / do not breed with outsiders;

2. Accept: inbreeding for 'individuals breed within group'

2. Accept: do not interbreed

2. ***Q*** *Reject: interbreeding for 'individuals breed within group'*

3. High(er) chance of inheriting allele (than in non-Amish population);

3. Do not award for 'allele passed on' only

3

(b) 250 000;

1

(c) (i) Loss of 3 bases / triplet = 2 marks;;

'Stop codon / code formed' = 1 mark max unless related to the last amino acid

Loss of base(s) = 1 mark;

eg triplet for last amino acid is changed to a stop codon / code = 2 marks

3 bases / triplet forms an intron = 2 marks

Accept: descriptions for 'intron' eg non-coding DNA

'Loss of codon' = 2 marks

2

(ii) 1. Change in tertiary structure / active site;

Neutral: change in 3D shape / structure

2. (So) faulty / non-functional protein / enzyme;

Accept: reference to examples of loss of function eg fewer E-S complexes formed

2

[8]